

ORIGINAL ARTICLE

DETERMINING THE GENERATION RATE AND COMPOSITION OF SOLID HEALTH CARE WASTE AT GONDAR UNIVERSITY HOSPITAL

Dagne Engdaw^{1*}, Hameed Sulaiman², Seyoum Leta²

ABSTRACT

Background: The unavailability or inadequacy of data about the quantity and composition of health care waste is one of the reasons for poor solid healthcare waste management. This study was done to assess the per bed generation rate and physical composition of solid healthcare waste so as to produce baseline data and recommend appropriate management options.

Methods: Gondar University Regional Referral Hospital which has 367 beds, 17 examination rooms, 6 supportive departments, 14 admission rooms grouped under 5 main departments and administrative offices was selected. The solid healthcare waste was collected and measured from Monday to Sunday consecutively by using plastic buckets of known color, mass and volume to estimate the amount of waste generated.

Results: The average generation rate of solid healthcare waste was found to be 0.95 kg/bed /day and 0.142 gm/outpatient/day in the inpatient and outpatient departments, respectively. The mean HCW generation in the seven consecutive days for general waste, infectious waste, sharp waste, pathological waste, pharmaceutical waste, and radiological waste were 184 ± 27.9 , 128 ± 27.3 , 3 ± 1.7 , 18 ± 5.4 , 6 ± 5.2 , and 3 ± 2 , kg, respectively.

Conclusions: Although the generation rate of health care waste was very less compared to other studies, the efficiency of proper management was poor. Based on the findings; it can be recommended that there is an urgent need for raising awareness and providing education on medical waste issues.

INTRODUCTION

Any anthropogenic activity generates some waste. For example, many industrial activities generate toxic waste and effluents while consumption activities generate various types of waste (1). Health-care activities lead to the production of waste that may lead to adverse health effects. However, most of this waste is not more dangerous than regular household waste. Of course, some types of health-care waste represent a higher risk to health. These include infectious waste (15% to 25% of total health-care waste) among which are sharp waste (1%), body part waste (1%), chemical or pharmaceutical waste (3%), and radioactive and cytotoxic waste or broken thermometers (less than 1%) (2, 3, 4). The generation rate of such waste differs not only from country to country but also within a country. Waste generation depends

on numerous factors, such as waste management methods, type of health-care establishment, specializations of the hospital, ratio of reusable items in use, ratio of day care proportion of patients treated on a daily basis (4,5).

Epidemiological studies indicate that a person who experiences one needle-stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3% to become infected with HBV, HCV and HIV, respectively (6). Each year, globally, the reuse of dirty injection equipment causes an estimated 8 to 16 million infections with hepatitis B virus, 2.3 to 4.7 million infections with hepatitis C virus, and 80, 000 to 160, 000 infections with HIV. Together, these chronic infections are responsible for an estimated 1.3 million early deaths and loss of 26 million years of life, and lead to US\$ 535 million in direct medical costs (7).

It is obvious that the amount and type of waste generated from healthcare activities in the country is not

¹Department of Environmental Health, School of Public Health, Gondar University, P.O.Box. No. 196, Gondar, Ethiopia. Fax: 00251-581-111479 Tel.No. +251918350017, E-mail:dagne4412@yahoo.com.

²Environmental Science Program, Faculty of Science, Addis Ababa University

*¹Corresponding author: Dagne Engdaw, Fax: 00251-581-111479 Tel.No.+251918350017, E-mail:dagne4412@yahoo.com

yet measured. Only very little research has been done in the area making it difficult for decision makers and experts to bring the issue into the priority agenda so as to develop management plan and policy. Therefore, This study was conducted with the objective of assessing the per bed generation rate and physical composition of solid healthcare waste at Gondar University Hospital in order to produce baseline data and to recommend appropriate management options.

METHODS

Study Design: A cross-sectional study design was used to address all objectives of the study.

Sampling Technique: The convenience sampling technique was used to select Gondar University Hospital. The hospital's 367 beds, 17 examination rooms, 6 supportive departments, 14 admission rooms grouped under 5 main departments and all administrative offices were included in the study.

Data Collection: Before the actual collection, measurement and sorting of the solid health care waste commenced, a three-day pre-test was carried out to evaluate the relevance and applicability of the method at the hospital to ensure the quality of data.

The solid healthcare waste was collected and measured daily from Monday to Sunday for seven days. Each bedroom, the OPD, laboratory, pharmacy, kitchen, and other supportive staff like laundry were provided with five plastic buckets of different colors and one safety box for sharp waste collection. The buckets, safety boxes and plastic bags were labeled to indicate the different categories of healthcare waste, date of collection and sample number.

The plastic bags were removed every morning and their weight and volume measured every day using a weighing scale and labeled bucket, respectively. The different categories of waste i.e. general waste, infectious waste, sharp waste, pathological waste, pharmaceutical waste and radiological waste were measured in different containers.

A different group of data collector was used to collect waste from administrative activities, the kitchen, and other sources. The study was carried out during April 2007.

Determination of HCW Generation Rate: Health care wastes were measured using labeled buckets of 5, 10, 15 and 20 liters each. After volume measurement weight determination was carried out using a calibrated sensitive weight scale. The wastes collected from each bed room using six containers for general, infectious, sharp, pathological, pharmaceutical and radiological wastes, respectively were further sorted and measured every day since source segregation was not perfect.

Finally the HCW generated per bed per day and per out-patient per day was determined by dividing the total health care waste generated by the number of occupied beds, and the healthcare waste generated in the out-patient department by the total out-patients on daily basis.

Data Analysis: Data was cleaned, entered and analyzed using the SPSS version 13 statistical package for windows. Descriptive outcomes were calculated using scores of mean, median and standard deviation P-values were calculated to check the statistical correlation among the different variables.

Ethical Issues: Ethical clearance from Addis Ababa University and permission from the office of medical director of University of Gondar Hospital was secured. Finally, the data were collected up on securing informed consent from all head nurses of the different wards.

RESULTS

The results of this study showed that the generation and composition of healthcare waste was different in different sections or wards of the hospital.

The highest quantities of hazardous waste were recorded at the surgical, maternity and gynecological wards, especially in the labor and operation rooms that is 36 and 28kg/day respectively (table 1).

Average HCW generation in the seven consecutive days for general waste, infectious waste, sharp waste, pathological waste, pharmaceutical waste, and radiological waste was 184 ± 27.9 , 128 ± 27.3 , 3 ± 1.7 , 18 ± 5.4 , 6 ± 5.2 , and 3 ± 2 , respectively (Table 2).

Table 1: Proportion of general waste and hazardous waste generated at GUH, April 2007

Ser. No.	Section	General waste			Hazardous waste		
		(kg/day)	(m ³ /day)	Kg/m ³ /day	(kg/day)	(m ³ /day)	Kg/m ³ /day
1	Medical ward	28.0	0.111	252.3	22.00	0.0954	230.6
2	Surgical ward	27.00	0.131	206.1	36.00	0.18	200.0
3	Gyn-Obs ward	10.00	0.05	200.0	28.00	0.098	285.7
4	Pediatrics ward	14.00	0.078	179.5	12.00	0.074	162.0
5	Ophthalmology ward	5.00	0.0197	253.8	5.00	0.025	200.0
6	Physiotherapy	4.00	0.021	190.5	2.00	0.015	133.3
7	Medical OPD	4.00	0.161	24.8	6.00	0.03	200.0
8	Surgical OPD	6.00	0.0384	156.3	8.00	0.049	163.3
9	Gyn-Obs OPD	6.00	0.036	166.7	6.00	0.045	133.3
10	Pediatrics OPD	1.00	0.0062	161.3	1.00	0.002	500.0
11	Other OPDs	8.00	0.052	153.8	8.00	0.06	133.3
12	Laboratories	9.00	0.0423	212.8	10.00	0.052	192.3
13	Pharmacy	3.00	0.0127	236.2	7.00	0.0397	176.3
14	Radiology	2.00	0.0173	115.6	5.00	0.016	312.5
15	Laundry	3.00	0.0138	217.4	2.00	0.0075	266.7
16	Kitchen	27.00	0.079	341.8	0.00	0.00	0.00
17	Offices	5.00	0.03	166.7	0.00	0.00	0.00
18	Open areas near to the wards	22.00	0.110	200	0.00	0.00	0.00
Total		184(54%)	1.00	184.0	158(46%)	0.87	181.6

Table 2: Mean, standard deviation, maximum, minimum, and total HCW generation (kg) in the seven days at different sections in GUH, April 2007.

	General	Infectious	Sharp	Pathological	Pharmaceutical	Radiological
Day 1	206	147.1	5.38	18.1	15	5.34
Day 2	223.7	146.5	4.95	23	9	3.6
Day 3	188.7	126.3	5.66	9.7	7	4.34
Day 4	190.8	139.5	3.012	22	5.5	2.67
Day 5	184.05	158	3.87	21.5	6	2.67
Day 6	156.74	97.65	1.52	12.4	0	0
Day 7	141.5	85.62	1.54	23	0	0
Mean	184	128	3	18	6	3
Maximum	223.7	158	5.88	23	15	5.340
Minimum	141.5	85.62	1.25	9.7	0	0
STDEV	27.9	27.25	1.73	5.4	5.2	2.04
Sum	1291.5	900.67	25.9	129.7	42.5	18.62

**HCW generation rate is assessed as follows
(Inpatient) Average daily waste in kg**

Total mean waste generated daily	342
Total mean occupied beds	359
Generation rate (kg/bed/day)	0.95

HCW generation rate from OPD

Total mean HCW from OPDs	54.0
Total mean patients at OPD	380.0
Generation rate (kg/client/day)	0.142

Among the various wastes generated general waste (53.82%), infectious waste (37.35%), and Pathological waste (5.29) have the lion share account respectively however pharmaceutical (1.76), sharp (0.88), and radiological waste (0.88) score the least.

The mean patient flow and HCW generation were 359 ± 3.9 , 342 ± 10.87 respectively. This shows the

generation rate is highly affected by patient flow. The line graph below (Fig. 2) shows a statistically significant correlation between patient flow and the generation rate of solid healthcare waste with P-

value of 0.002. The fluctuation of occupied beds in the study hospital was very small but the generation rate was highly affected.

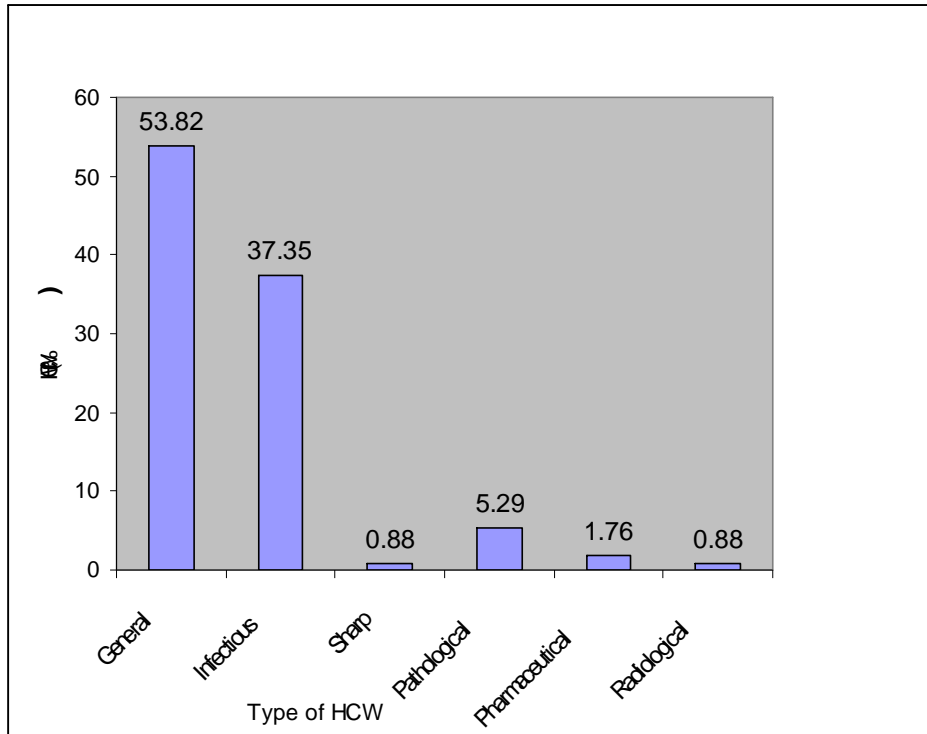


Figure 1: HCW generation rate by physical composition in GUH, April 2007

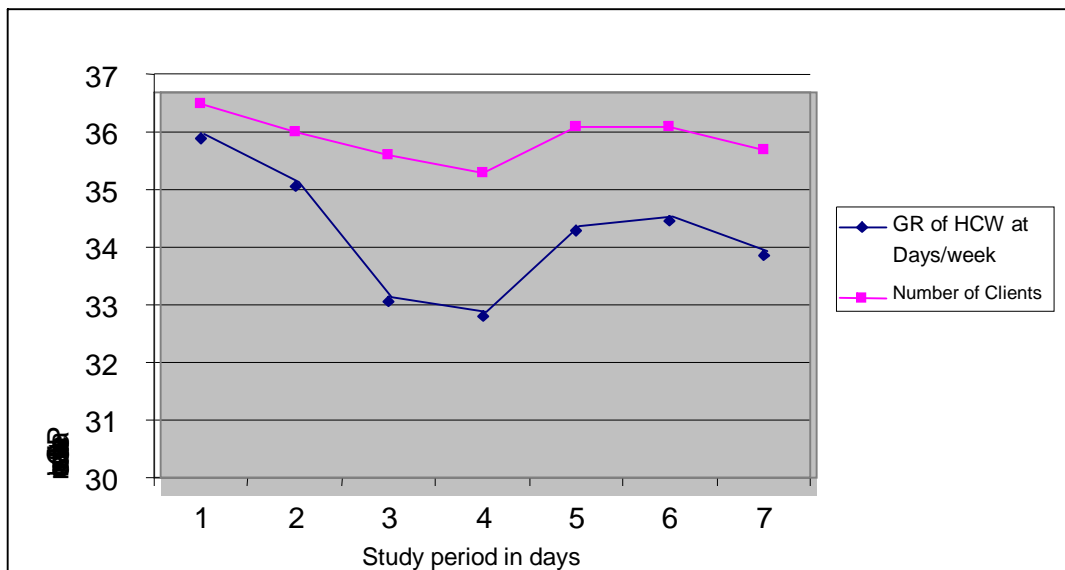


Figure 2: The generation rate and patient flow in the study period at GUH, April 2007

DISCUSSION

The generation and composition of healthcare waste was different in different sections or wards of the hospital (table 1). The variation could be due to the characteristics of each unit which required a different type of diagnosis and treatment. Some diagnosis and treatment methods produced more waste than others.

Compared to the overall waste produced at each specific ward, the highest quantities of hazardous waste were recorded at the surgical, maternity and gynecological wards, especially in the labor and operation rooms (table 1). This may be due to the fact that at least six mothers delivered daily during the study period. Studies elsewhere also demonstrated that facilities which produced larger quantities of hazardous wastes were in the maternity and gynecological sections and the operation theater (8).

Average HCW generation in the seven consecutive days for General waste, Infectious waste, Sharp waste, Pathological waste, Pharmaceutical waste, and Radiological waste was 184 ± 27.9 , 128 ± 27.3 , 3 ± 1.7 , 18 ± 5.4 , 6 ± 5.2 , and 3 ± 2 , respectively (Table 2). The variation between different types of waste may be due to differences in the number of beds covered, types of cases diagnosed and treated in the stated period of time.

This study showed that there was a significant difference in mean HCW generation rate between waste types (p value <0.05). The significant variation of means of the different types of waste might be due to the type of service demanded by the patients (medical, surgical, gynecological, etc), type of facility available in the different departments or cases of patients, number of patients demanding each specific type of service, etc

General waste was the largest (53.82%) of the various types of waste. That was, perhaps, because it was a combination of the waste of such supportive departments as the office, the kitchen, outdoors and patient care activities. Similar studies showed estimates of the general portion of HCW that is 80%, 75-90%, 51.5%, respectively (2, 7, and 10).

Although the percentage of the different studies differs, it is clear that if source segregation is accomplished, the general portion of the HCW will have the lion's share. It is also clear that the quantity of

sharp waste is the least, about 1%. This may be due to limited sources of generation, that is, except admitted patients and emergency cases, the rest of the patients take injections at nearby health facilities. The percentage is compatible with that of other studies which is 1% (2).

Waste generation was also estimated for the inpatient and out-patient departments. The result of this study revealed that 0.95 kg/bed/day and 0.142 kg/patient/day healthcare waste was generated in the inpatient and out patient departments, respectively. The waste generated in the outpatient department was far less than that of the inpatient department. This might be because: (1) the outpatients were included to the inpatients during calculation, (2) the clients in the outpatient department stayed for a short period of time that is until they saw their physicians, (3) they demand only limited hospital service.

In conclusion the results of this investigation indicated that 54%, 37%, 5%, 2%, 1% and 1% general, infectious, pathological, pharmaceutical, radiological and sharp wastes respectively were generated. The total hospital waste was found to be 342 kg/day. The generation rate per bed per day was found to be about 0.95 kg/bed/day which was extremely low compared to that of developed countries which generate up to 8 kg/bed/day. Out of the overall HCW, the hazardous portion was found to be 158 kg/day (46%) by weight and 0.87 m^3 by volume.

Based on the findings, we recommend the following:

1. Pathological waste should be managed in placenta pit.
2. Pharmaceutical wastes should either be reused or turned back to the manufacturer.
3. Radiological waste should be recycled.
4. Hazardous portion of HCW should be incinerated with the available incinerators.
5. Infectious waste should be sterilized at each section using the available autoclaves before it is sent to the final disposal options.
6. General waste should be composted.

ACKNOWLEDGEMENT

The authors acknowledge Gondar University Hospital and the staffs supporting our investigation. We are very much grateful to Almighty God, Saint Marry and all our families.

REFERENCES

1. Akter N. Medical waste management. 2000, A review. No.1. Asian Institute of Technology.
2. Pruss A., Giroult E. and Rushbrook P. Safe management of wastes from healthcare activities. *Bulletin of the World Health Organization*. 1999, 79(2):1-226.
3. WHO. Safe healthcare waste management. 2004, Policy paper. No. 27. Geneva, World Health organization.
4. Nessa KMA., Quaiyum MA. and khuda B. Waste management in healthcare facilities, A review; ICDDR, B Working paper. 2000, 144 (39):1-25.
5. Pruss A. and Townend WK. Management of wastes from healthcare activities. Teacher's guide. Geneva: 1998 1st ed.
6. WHO. Preparation of national healthcare waste management plans in sub-Saharan countries. *WHO Guidance manual*. 2004. 1(1):1-87.
7. WHO. Injection safety report by the secretariat. *Bulletin of World Health Organization*, 2000. 107(23):1-2.
8. Ahmed R. Hospital waste management. Pakistan: WASTE, 1997, 1st ed.
9. Tchobanoglous G., Theisen H. and Eliasse A. Solid waste engineering principles and management issues. Tokyo: McGraw-Hill, Kogakusha, ltd. 1977, 1st ed.
10. Askarian M., Vakili M. and Kabir G. Hospital waste management in the university hospitals of the Fars province. *International journal of environmental health research*. 2000. 14 (4): 295-05.